the details of the third metamorphosis. Some of the specimens were given to the local sericultural school for experimental breeding, and by it distributed so that a number of silk growers in the vicinity are now rearing the trivoltine form.

The cave is described as lying in the south side of a mountain leading downward about 350 yards. The interior is moist and dripping. The temperature as mentioned before is 60°.

The larvæ were placed in a corner of the cave on the top of a "coal oil box" and enclosed in a double packing box (such as is used for storing treasures in go-downs). This box measured externally two feet square by one and a half feet high. The inner wall, one foot two inches square by about one foot high. The space between was filled with sawdust. (Apparently no record was made of the temperature of the interior of the box.)

In concluding, Mr. Tsukai remarks that some successful results have been recently reported in changing a trivoltine race into a quadrivoltine, presumably by the same method. He attributes the change to an inhibition of development through a lowering of the temperature. If so, it should be easy to reproduce the results described.

If it is true that the bivoltine races can be converted into trivoltine so easily, it would seem unlikely that the condition of bivoltism can be explained as a case of reversion.

J. F. Abbott

Washington University

## *The American Association for the Advancement of Science*
## *Section B—Physics*

The annual meeting of the American Association for the Advancement of Science, Section B, was held in Boston, beginning Tuesday morning, December 28, and closing Friday noon, December 31, with two sessions daily. All sessions except that on the closing day were joint sessions with the American Physical Society. That on Tuesday afternoon was participated in also by Section A, and that on Friday was a joint session with Section L. The presiding officers were Vice-president Bauer, of Section B, and President Crew, of the American Physical Society. All the meetings were held in the physics lecture room of Walker Building, Massachusetts Institute of Technology, except on Wednesday, when both sessions were held in Cambridge at the Jefferson Laboratory of Harvard University. The attendance was uniformly good, varying from one hundred to two hundred. Fifty-nine papers and addresses were presented at the meeting.

On Wednesday evening there was an informal dinner for physicists at the Hotel Vendome and on Thursday afternoon a reception was given to all visiting physicists and their ladies by President and Mrs. Maclaurin of the Massachusetts Institute of Technology, at their home. Both of these were well attended and greatly enjoyed. An informal dinner and conference of the officers of Section B and of the American Physical Society on Tuesday evening led to a satisfactory plan for a more complete cooperation of the two organizations and a better agreement with respect to the range of activity of each.

A short business session on Tuesday resulted in the selection of the following officers for the meeting next Christmas at Minneapolis:

*Vice-president and Chairman of Section*—E. B. Rosa, Washington, D. C.

*Secretary*—A. D. Cole, Columbus, O.

*Member of Council*—W. S. Franklin.

*Sectional Committee*—L. A. Bauer, E. B. Rosa, A. D. Cole, A. Trowbridge, A. P. Carman, G. F. Hull and E. L. Nichols.

*Member of General Committee*—F. P. Whitman.

Several new members were added to the section and fifty members were made fellows of the association.

At the joint sessions on Tuesday afternoon and Friday morning an effort was made to provide programs that would be of interest to others than physicists. The papers presented were wholly by invitation. The large audiences—approximately two hundred in each case—and the interest shown demonstrated the success of this effort and led to a decision to adopt the "general-interest session" as a permanent policy. The program on Tuesday was presented by Sections A and B jointly and that on Friday by Section B. These programs follow.

### Tuesday Afternoon, December 28

*Some Reforms needed in the Teaching of Physics* (vice-presidential address of Section B): Professor Karl E. Guthe, of the University of Michigan.

*On the Determination of Latitude and Longitude in a Balloon:* Professor C. RUNGE, of the University of Berlin.

*The Ruling of Diffraction Gratings:* Professor A. A. MICHELSON, of the University of Chicago.

*On Certain Physical Hypotheses sufficient to explain an Anomaly in the Moon's Motion:* Professor E. W. BROWN, of Yale University.

Professor Guthe's address has been printed in full in SCIENCE, January 7, 1910, and an abstract of that of Professor Runge is printed in SCIENCE for January 28 (Report of Section A). Abstracts of the other two are given below:

*On the Ruling of Diffraction Gratings:* A. A. MICHELSON, University of Chicago.

The difficulty with the echelon and other interferential methods of great resolving power lies in the large number of overlapping spectra. In the grating great regularity in spacing is required if high resolving power is sought. The use of the cadmium red line makes it possible to secure the needed regularity in spacing, since the alternations of dark and light interference bands can be observed through 250,000 wave-lengths.

After long labor it has been found possible to make gratings as efficient in resolving power as are the echelon and other interferential apparatus. An idea of the accuracy required is gained from the consideration that errors must not exceed .00001 inch when not systematic; if they are systematic much greater accuracy than this is necessary to avoid "ghosts," say to .000001 inch. The best screws when they come from the lathe have errors of about .001 inch. By grinding, say a month, with a special nut, these can be reduced to about .0001, and by further labor to .00002 inch. Beyond this, local processes of correction become necessary.

To secure gratings of sufficient length for the great resolving power desired, it was necessary to use a screw three times as large as that used in Rowland's machines. His method of grinding was tried for a long time without securing satisfactory results. By the use of a grinding nut cut into three parts and with very fine emery success was finally reached. The use of too coarse emery in order to save time caused the wearing out of one screw before its errors were removed. Attempts to grind under oil and under water were made, but given up. Finally the following method was used: grinding for several months with the nut kept wet with soap and water; errors were then determined with the interferometer; then a correcting nut with an arrangement for rubbing harder on one side of the thread than the other was applied. In this way the errors were brought down to about .000002 inch. (The method for the final correction was also described.)

To work in the second-order spectrum 250,000 lines, or a grating fifteen inches long, was needed. To secure necessary rigidity in a screw long enough to rule this length, it must weigh thirty or forty pounds. Nine tenths of this weight was sustained by floating on mercury. Steel can not be used for the nut; a yielding material is required. Wood was used, as by Rowland. As great accuracy of ways is necessary, one bearing surface only was used instead of four as in a lathe. Great trouble was found in securing suitable diamonds for ruling. No difficulty was found the first year, after that not a good one was found for six years. Finally through Sir Wm. Crookes a satisfactory diamond was obtained from a certain mine which yields extra hard stones. To prevent undue wear very light pressure only on the tracing point was used, and the ruling subsequently deepened by etching. Only flat gratings have been ruled, as these can be made of higher accuracy than concave gratings.

*On Certain Physical Hypotheses sufficient to explain an Anomaly in the Moon's Motion:* ERNEST W. BROWN, Yale University.

Newcomb has shown that there is a difference between the observed and theoretical positions of the moon which can be roughly represented by a term of period about 270 years and coefficient 13″.

In the paper the author has examined numerous hypotheses sufficient to explain the term, in order to clear the ground of those which seemed to be of doubtful value and to bring forward those which appeared sufficiently reasonable to merit tests from observations of a different nature. Some account of three of these hypotheses was presented to the meeting. It was stated that a minute libration of the moon would be sufficient, provided it took place in the moon's equator and had the proper period. The supposition of magnetic attraction practically demanded (*a*) a periodic change in the magnetic movement of the earth or of the moon. If (*a*) were rejected, it was necessary to suppose that the mean place of the lunar magnetic axis was near the lunar equator and that the oscillations of its position took place in the plane of the equator. The observed secular change of the earth's magnetic axis could not

produce the phenomenon without demanding a larger motion of the lunar perigee than observation warrants. On the border line between two sets of hypotheses was a curious fact, namely, that if the period of the solar rotation coincided very nearly with one of the principal lunar periods a minute equatorial ellipticity of the sun's mass was sufficient to explain the term. So far as known, these hypotheses do not conflict with any observed phenomena, but they cause some theoretical difficulties.

PROGRAM OF THE JOINT SESSION OF SECTION B AND SECTION L, FRIDAY MORNING, DECEMBER 21

*The Relation of Colleges to Secondary Schools with respect to Physics:* Professor E. H. HALL, of Harvard University.

*What Specialization has done for Physics Teaching:* Professor JOHN F. WOODHULL, Teachers College, Columbia University.

*The Quantitative Teaching of Kinetics in Secondary Schools:* N. H. BLACK, of Roxbury Latin School, Boston.

*The Place of "g" in High School Teaching and other Topics:* Professor A. G. WEBSTER, of Clark University.

*College Attitude toward Preparatory Work:* Professor C. R. MANN, University of Chicago.

These papers were followed by an animated general discussion in which the following educators participated: Professors Guthe, of the University of Michigan; Hall, of Harvard; Franklin, of Lehigh; President McNair, of Michigan School of Mines; Professors Webster, of Clark; Woodhull, of Columbia; Mann, of Chicago; Hull, of Dartmouth; Rosa, of the Bureau of Standards, and Slate, of the University of California.

At the joint sessions of the American Physical Society and Section B, the following forty-nine papers were presented. Abstracts of many of these papers may be found in the February number of the *Physical Review* and others may be expected in later numbers of the same periodical.

*Temperature Coefficient of Electrical Resistance—Tungsten, Molybdenum, Nickel and Nichrome:* A. A. SOMERVILLE.

*The Flow of a Gas through a Capillary Tube:* WILLARD J. FISHER.

*Effect of Surface Tension upon a Falling Jet of Water:* F. R. WATSON.

*The Variation of the Hall Effect in Metals with Change of Temperature:* ALPHEUS W. SMITH.

*The Effect of Pressure on the Electrolytic Rectifier:* A. P. CARMAN and G. J. BALZER.

*The Analysis of the Principal Mercury Lines by Diffraction Gratings and a Comparison with the Results obtained by other Methods:* HENRY G. GALE and HARVEY B. LEMON.

*The Spectra of some Gases in the Region of Extremely Short Wave-length:* THEODORE LYMAN.

*The Variation of the Hall Effect with the Temperature in the Case of the Principal Magnetic Metals:* THOMAS C. MCKAY.

*The Rectifying Effect in Point and Plane Discharge:* ROBERT F. EARHART and CHAS. H. LAKE.

*Photographic Photometry, and some Interesting Photographic Phenomena:* CHARLES F. BRUSH.

*Note on "Changes in Density of the Ether, and some Optical Effects of Changes in Ether Density":* CHARLES F. BRUSH.

*The Tone Quality of the Flute:* D. C. MILLER.

*An Instrument for Projecting and Recording Sound Waves:* D. C. MILLER.

*The Magnetic Measurements on Board the "Carnegie" in 1909:* L. A. BAUER.

*The Relativity Dilemma:* D. F. COMSTOCK.

*"Bound Mass" and the Fitzgerald-Lorentz Contraction:* WILL C. BAKER.

*Physical Properties of Binary Liquid Mixtures:* J. C. HUBBARD.

*On the Use of Polar Coordinates in Thermodynamics:* J. C. HUBBARD.

*The Theory of the Vibration Galvanometer:* F. WENNER.

*Coefficients of Linear Expansion at Low Temperatures:* H. G. DORSEY.

*The Freezing of Mercury at High Pressures:* P. W. BRIDGEMAN.

*Phenomena of Spark Discharge through Wire Conductors:* FRANCIS E. NIPHER.

*Some Minute Phenomena of Electrolysis:* H. W. MORSE.

*A New Method of Measurement of Small Angles:* C. W. CHAMBERLAIN.

*The Photographic Evidence for Dispersion of Light in Space—Is it a purely Photographic Phenomenon?* H. E. IVES.

*On the Secondary β Radiation from Solids, Solutions and Liquids:* S. J. ALLEN.

*The Effect of Filter Paper upon the Mass and Form of the Deposit, in the Silver Coulometer:* E. B. ROSA, G. V. VINAL and A. S. MCDANIEL.

*Experiments in Impact Excitation with the Lepel Singing Arc:* GEORGE NASMYTH.

*On the Coefficients of Diffusion of the Emanation and the Active Deposit Particles of Actinium:* J. C. MCLENNAN.

*On the Relative Numbers of Positive and Negative Ions present in Atmospheric Air:* A. THOMSON.

*Note on the Cause of the Discrepancy between the Observed and Calculated Temperatures after Expansion in the Space between the Plates of a Wilson Expansion Apparatus:* R. A. MILLIKAN, E. K. CHAPMAN and H. W. MOODY.

*Some New Values of the Positive Potentials assumed by Metals under the Influence of Ultra-violet Light:* R. A. MILLIKAN.

*The Second Order Effect of Ether Drift on the Intensity of Radiation:* A. TROWBRIDGE and C. E. MENDENHALL.

*The Rotary Dispersion of Quartz at −190° C. and Observations at other Temperatures:* F. A. MOLBY.

*The Pyrheliometric Scale and the Solar Constant:* C. G. ABBOT.

*Single-line Series in the Spectra of Ca and Sr:* F. A. SAUNDERS.

*The Relative Motion of the Earth and the Ether:* H. A. WILSON.

*A Study of the Multiple Reflection of Short Electric Waves between two Reflecting Surfaces:* L. E. WOODMAN and H. W. WEBB.

*A Hot Air Engine Indicator Diagram:* A. G. WEBSTER.

*The Nitrogen Thermometer from Zinc to Palladium:* A. L. DAY and R. R. SOSMAN.

*On Calcium Clouds in Space:* Dr. STIFER (presented by Percival Lowell).

*The Second Postulate of Relativity:* R. C. TOLMAN.

*The Terminal Velocity of Fall of Small Spheres in Air:* JOHN ZELENY and L. W. MCKEEHAN. (By title.)

*The Present State of our Knowledge concerning Permanent Magnetism:* A. A. KNOWLTON. (By title.)

*The Heat of Dilution of Aqueous Salt Solution:* F. L. BISHOP. (By title.)

*Uranous and Uranyl Bands—A Very Fine Band Absorption Solution Spectrum:* W. W. STRONG. (By title.)

*Insulation of Observatory Domes for Protecting Telescopes and other Apparatus against Extremes of Heat and Cold:* DAVID TODD. (By title.)

*On the Free Vibrations of a Lecher System:* F. C. BLAKE and CHAS. SHEARD. (By title.)

*Thunderstorm Electricity:* W. W. STRONG. (By title.)

ALFRED D. COLE,
*Secretary*

OHIO STATE UNIVERSITY

## *SECTION L—EDUCATION*

THE Boston meeting of Section L was unusually successful. The attendance varied from 50 to 110. The policy of the section of devoting each session to a single topic was again carried out. The section committee has voted to continue this policy for future meetings. President A. Ross Hill, of the University of Missouri, was elected the vice-president of the section and Professor John Dewey, of Columbia University, was elected member of the sectional committee.

Probably the most important contribution to the meeting was the address of the retiring vice-president, Professor Dewey, on "Science as Method and as Information." With great clearness it was pointed out what results follow from considering science merely as information and from teaching it accordingly. Only when science is studied as a universal method of obtaining knowledge will science take the important place that is now awaiting it in educational work. The paper has been printed in full in SCIENCE for January 28.

The first session of the section was devoted to a discussion of the topic, "Formulated Scientific Problems in General Education." The first speaker was Professor Edward L. Thorndike, of Columbia University.

He showed that a scientific treatment of education demands means of measuring the facts, changes and relations with which education is concerned. Some useful units of measure and scales for measuring are furnished by physiology, psychology and allied sciences. But in such cases as amount of knowledge of a language, degree of ability in English composition, quality of handwriting, improvement in manners or morals and the like students of education should devise units of measure and arrange scales for teachers. Any product or response or quality which varies in amount can be measured even though it is complex, subtle and subject to an enormous effect from the personal equations of observers.

The desiderata in a scale for the measurement of educational facts are: (1) that the points on the scale be defined with exactitude, (2) that a difference of one should have the same value no matter where on the scale it occurs, (3) that the values attached to points on the scale should all refer to a defined and useful zero, preferably one signifying no amount whatever of the fact in question, and (4) that the scale be convenient